ORIGINAL PROF-627

DISTRIBUTION OF CELL TYPES OF THE ISLETS OF LANGERHANS IN THE PANCREAS OF THE ALBINO RATS

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ABSTRACT

The rat pancreas is an irregularly shaped, elongated organ extending between the duodenum and spleen. **OBJECTIVE:** The distribution of the islets of Langerhans of the pancreas with different cell types in different regions of the pancreas was observed in this study. **SETTING:** Basic Medical Science Institute, JPMC, Karachi. **MATERIAL & METHODS:** 12 animals were included in present study. The animals were sacrificed under ether anaesthesia. Tissues were processed and three microns thick sections were cut and stained with haematoxylin and eosin and chrome-alum haematoxylin phloxine stain, examined under low and high magnifications of light microscope. **RESULTS:** The study of the tissues showed greater number of the islets of Langerhans in the tail and the body than in the head of the pancreas. No significant difference was observed in the size of islets. There were more cells per islet in the tail than the head and the body. The alpha and the delta-cells were more abundant in the head than in the body and the tail of the pancreas while the beta-cell were more abundant in the tail of the pancreas. The mean nuclear diameter of the alpha and the beta-cell was more in the head and the body than in the tail while the mean nuclear diameter of the delta-cell was more in the body than in the head and the tail and the alpha and the delta-cells appeared to be larger than the beta-cell. The cytoplasm of the alpha, the beta and the delta-cell was granular with centrally located round to oval nuclei. The present study showed that the alpha-cells were located mostly at the periphery, the delta-cell at the junction of the centre and the periphery while the beta-cell were located in the centre of the islets. **CONCLUSION:** The present study showed greater number of Islets of Langerhans in tail and the body as compared to the head region. The alpha-cells were located at the periphery of islets, the delta-cells were located at the junction of centre and the periphery, and the beta-cells were located mostly in the centre of islets.

INTRODUCTION

The rat pancreas is an irregularly shaped, elongated organ extending between the duodenum and spleen[1]. It consists of a dorsal part comprising upper part of the head, the body and the tail and a ventral part comprising the lower part of the head. The two parts have different developmental origins, supplied by two different arteries, and are drained by two different ducts[2,3]. The endocrine pancreas consists of islets of Langerhans each of which is composed of the alpha, the delta, the PP and delta-1 cells. The islets is divided into an outer cortex (the alpha, the beta and the delta cells) and a central medula (mostly the beta-cell). The ventral islets are rich in the PP-cells while the dorsal islets are rich in the alpha-cell[4].

Islets of Langerhans are dispersed randomly in the

exocrine tissue and are more numerous in the body and tail than in the head. In ordinary preparations, the islets appear as more or less spheroidal or ellipsoidal mass of pale staining cells, arranged in the form of irregular anastomosing cords. Between the cords are numerous blood capillaries[5], the size of islets varies from those having only a few cells to islets which are macroscopically visible. Isolated islets cells are also found occasionally among the cell linking the ducts of the exocrine pancreas[6]. Of the different types of cells, the alpha and the beta-cells are by far the most numerous. The beta-cells comprise 60-90% of all the islets cells. Both the alpha and the beta-cells have granules in their cytoplasm. The granules of the alpha-cells are preserved by alcohol, stained red with chrome-alum haematoxylin phloxine stain, aldehyde fuchsin negative, relatively uniform in size and have evenly distributed cytoplasm. The granules of the beta-cell are not preserved by alcohol, stained blue with chrome-alum haematoxylin phloxine stain, aldehyde fuchsin positive, vary in size, shape and distribution[6]. The delta-cells are stained red to clear pink with chrome alum haematoxylin phloxine stain[7]. The present study was designed to investigate the distribution of islets of Langerhans with cell types in different regions of pancreas in albino rats.

MATERIALS & METHODS

The animals used for experimental study were adult male albino rats of JPMC strain. A total of twelve animals weighing between 100 & 200 grams were selected for experimental study. The animals were numbered with ear puncture.

Sacrifice of Animals

The animals were anaesthetized with ether, placed on a dissecting board and their abdomen opened with a long midline incision. Pancreas was identified (figure-1) and its gross appearance was noted with magnifying lens. Pancrease was removed & divided into the head, the body and the tail (Figure-2). The tissue were immediately transferred to formal saline for fixation to prevent the autolysis of the pancreas which would otherwise occur very rapidly.

Tissue Treatment

All three parts of pancreas were fixed in formal saline for 18 to 24 hours, dehydrated in ascending grades of alcohol, cleared in xylene, and embedded in paraplast. Three microns thick longitudinal sections were cut on

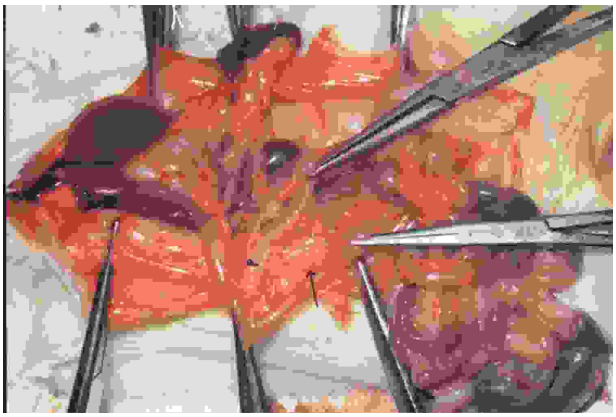

Figure-1

rotary microtome, floated in hot water bath and mounted on thoroughly clean gelatinised glass slides appropriately numbered with diamond pencil. The slides were placed on a hot plate at 37°C for 24 hours for fixation of sections & stained with heamatoxylin & eosin (H&E), and chrome alum haematoxylin pholxin stain.

Study of Sectioned Material

In Haematoxylin (H & E) stained sections, general morphology of the exocrine & endocrine pancreas was observed. The shape of islets, arrangement of cells in the islets, number of islets per unit area in different regions, the size of islets, total number of cells per islet were observed. With chrome-alum haematoxylin phloxin stain, morphology of individual cell was observed. The location & number of alpha, beta & delta cells were observed. Cytoplasm for granules, nuclei for shape, location in cells, staining intensity, presence or absence of nucleoli were all observed. The results were analyzed statistically.

RESULTS

The present study was designed to observe the distribution of the islets of Langerhans with different

cell types in the different regions of the pancreas as shown in Table-1.

The islets of Langerhans were observed for shape, general arrangement of cells, number per unit area, size, total number of cells per islet, number of the alpha cells, beta-cells and the delta-cells per islet, and locations of the alpha, the beta and the delta-cells in the islets. The cytoplasm of the alpha, the beta and the delta-cells was observed for the presence or absence of granules and vacuoles and for the staining intensity while the nuclei of the alpha, the beta and delta-cell were observed for their shape, location in the cytoplasm, size, staining intensity and for the presence or absence of nucleoli.

The morphological observations were based on the study of 3 microns thick, paraplast embedded H&E and chrome-alum haematoxylin phloxine stained sections.

The islets of Langerhans were dispersed among the exocrine tissue. They appeared as ovoid or irregularly shaped masses consisting of pale staining cells in all the three regions of the pancreas i.e. the head, the body and the tail (Figure 3,4). The cells were arranged in the form of clumps or irregular anastomosing cords with intervening capillaries (Figure 3,4,5).

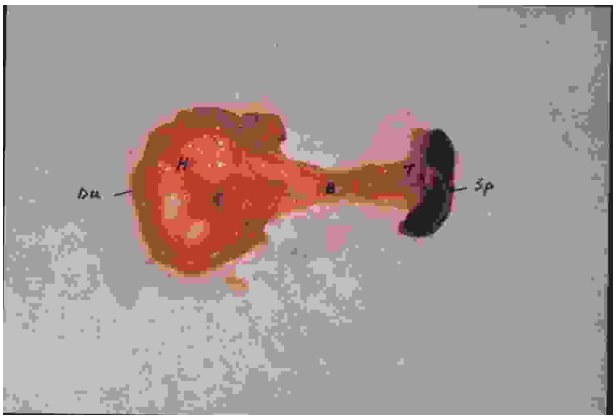

Figure-2

1. A highly significant increase ($P<0.001$) in the mean number of islets was observed in the tail region when compared with the head and the body as shown in Table -II.

Table I. Mean ± S.E.M. of the different observations in three regions of the pancreas in albino rats.

S. No.	Observations	Head	Body	Tail
1.	Mean No. of islets / unit area	1.75 ± 0.25	2.38 ± 0.26	3.88 ± 0.29
2.	Mean size of islets (microns)	135.26 ± 12.45	101.46 ± 11.53	133.86 ± 12.80
3.	Mean No. of total cells / islet	99.71 ± 16.55	75.11 ± 11.51	111.03 ± 12.66
4.	Mean No. of alpha cells / islet	20.28 ± 3.67	11.00 ± 2.87	4.81 ± 1.14
5.	Mean No. beta cells / islet	68.14 ± 13.36	54.68 ± 9.74	95.84 ± 11.73
6.	Mean No. delta cells / islet	4.71 ± 1.20	2.53 ± 0.88	0.94 ± 0.28
7.	Mean nuclear diameter of alpha-cell (Microns)	4.54 ± 0.08	4.52 ± 0.09	4.26 ± 0.06
8.	Mean nuclear diameter of beta-cell (Microns)	4.11 ± 0.11	3.81 ± 0.09	3.69 ± 0.07
9.	Mean nuclear diameter of delta-cell (Microns)	4.73 ± 0.82	4.81 ± 0.09	4.64 ± 0.12

Table-II. Statistical analysis of the difference in mean of different observations between the different regions of the pancreas in albino rat. (X + S.E.M.)

S. No.	Observations	Statistical comparison between Head and Body	Statistical comparison between Head and Tail	Statistical comparison between Body and Tail
1.	Mean No. of islets / unit area	0.625 ± 0.36 (N.S)	2.125 ± 0.386****	0.42 ± 0.39***
2.	Mean size of islets (microns)	33.79 ± 16.97 (N.S)	1.397 ± 17.86 (N.S)	32.40 ± 17.23 (N.S)
3.	Mean No. of total cells / islet	24.16 ± 20.16 (N.S)	11.30 ± 20.84 (N.S)	35.92 ± 17.11*
4.	Mean No. of alpha cells / islet	9.29 ± 4.66 (N.S)	15.48 ± 3.84****	6.19 ± 3.08 (N.S)
5.	Mean No. beta cells / islet	13.46 ± 16.85 (N.S)	20.69 ± 18.08 (N.S)	41.16 ± 15.25**
6.	Mean No. delta cells / islet	2.18 ± 1.49 (N.S)	3.77 ± 1.23***	1.59 ± 0.92 (N.S)
7.	Mean nuclear diameter of alpha-cell (Microns)	0.015 ± 0.118****	0.275 ± 0.094***	0.26 ± 0.106**
8.	Mean nuclear diameter of beta-cell (Microns)	0.299 ± 0.02 (N.S)	0..419 ± 0.126***	0.12 ± 0.12 (N.S)
9.	Mean nuclear diameter of delta-cell (Microns)	0.08 ± 0.82	0.09 ± 0.82 (N.S)	0.17 ± 0.13 (N.S)

Key: * = P < 0.05, ** = P<0.02, *** = P<0.01, **** = P< 0.001, N.S. = Non-Significant

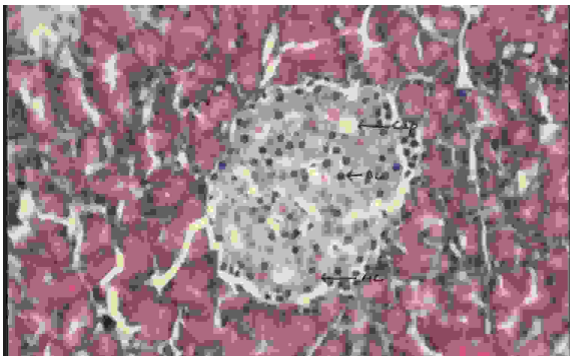

Figure-3

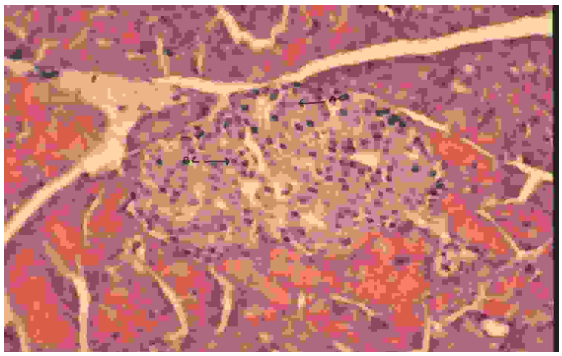

Figure-4

When the mean sizes of the islets were compared between the head, the body and the tail, the differences were statistically insignificant, as shown in table -II.

2. A significant increase (P<0.05) in the total number of cell per islets was observed in the tail when compared with the body as shown in table -II.

3. A highly significant increase (P<0.001) in the mean number of the alpha-cell per islet was observed in the head when compared with the tail as shown in table -II.

4. A significant increase (P<0.02) in the mean number of the beta-cell per islet was observed in the tail when compared with the body as shown in table -II.

5. A highly significant increase (P<0.01) in the mean number of the delta-cell per islet was observed in the head when compared with the tail as shown in table -II.

6. A highly significant increase (P<0.01) in the mean nuclear diameter of the alpha-cells in the head was observed when compared with the body and the tail as shown in table -II.

7. A highly significant increase (P<0.001) in the mean nuclear diameter of the beta-cells in the head was observed when compared with the tail (P<0.01) as shown in table -II.

8. When the mean nuclear diameters of the delta-cells were compared between the head and the body tail, the differences were statistically insignificant as shown in table-II.

In most of the islets, the alpha-cells were located at the periphery (Figure-5), however, in some islets they were found to be located in the centre. The cytoplasm of the alpha-cell was granular, non-vacuolated, abundant and stained light blue with chrome-alum haematoxylin phloxin stain. The nuclei were round to oval in shape, located in the centre of cell, stained pink with chrome - alum haematoxylin phloxin and had no prominent nucleoli.

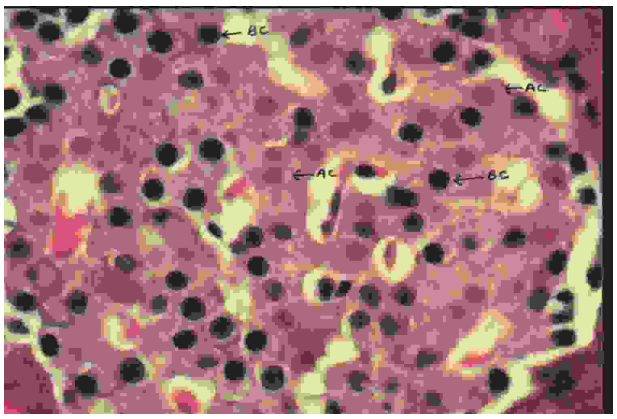

Figure-5

The distribution of the beta-cell in the islet in the head, the body and the tail was more consistent (Figure 3,4). In the most of the islets, the beta-cells were located in the centre of islets. The cytoplasm of the beta-cell was also granular, non-vacuolated, sparse in amount, and stained light blue with chrome-alum haematoxylin phloxin stain. The nuclei were round to oval in shape, located in the centre of cell, stained deep blue with chrome - alum haematoxylin phloxin stain and showed prominent nuclei.

The delta-cells were located at the junction of centre and the periphery. Most of the delta-cell were in contact with the alpha-cells. The cytoplasm of the delta-cell was granular and vacuolated, abundant and stained light blue with chrome - alum haematoxylin phloxin stain. The nuclei were round to oval in shape, located in the centre of cells, stained clear pink with chrome - alum haematoxylin phloxin stain and showed no prominent nuclei.

DISCUSSION

The varying distribution of cells in different parts of the pancreas was reported in 1976 by Orci et al[8], in the rats with alpha-cell rich islets occurring in the head, the body and the tail. Similar results were seen in human pancreas.

A three dimensional reconstruction of rat pancreas by Beatens et al[9] confirmed earlier findings of Orci et al[8] of alpha -cell rich islets in the head, the body and the tail. Similar results were observed in human pancreas[10]. It was suggested from the work on the dogs and the humans that the concentration of the alpha-cell and the beta-cells is significantly higher in the body and the tail of the pancreas. These results seem to suggest a non-random arrangement of cells within an islet or islet within the pancreas and raises the question of whether there is a functional significance of this arrangement.

In the present study, the number of islet per unit area were found to be more in the tail and the body of the pancreas than in the head. These findings are in agreement with the findings of Beatens et al[9].

No significant difference was observed in the size of islets in different regions. No literature is available for comparison with our findings. A significant increase in the number of total cells per islet was observed in the

tail when compared with the body of pancreas. The reason for this difference could be attributed to the less number and small size of islets in the body than in the tail of the pancreas. No literature is available for comparison with these findings of our study.

The alpha and delta-cells were most abundant in the head and the body of the pancreas and least in the tail of the pancreas while the beta-cells were most abundant in the tail than in the head and the body of pancreas. These findings of our study are in agreement with the work of Beatens et al[9], and Wolfe-coote and Dutoit[11].

The mean nuclear diameter of the alpha-cells and the beta-cells was larger in the head and the body than in the tail of pancreas. This showed that the alpha and the beta-cells were larger in the head and the body than in the tail and this could probably explain the increase in number of total cells per islet in the tail than in the head and the body of the pancreas. No literature is available for comparison with our findings.

The present study showed that the alpha-cells were located at the periphery of islets, the delta-cells were located at the junction of centre and the periphery, and the beta-cells were located mostly in the centre of islets. These findings are in agreement with the observations of Ocri and Unger[4].

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